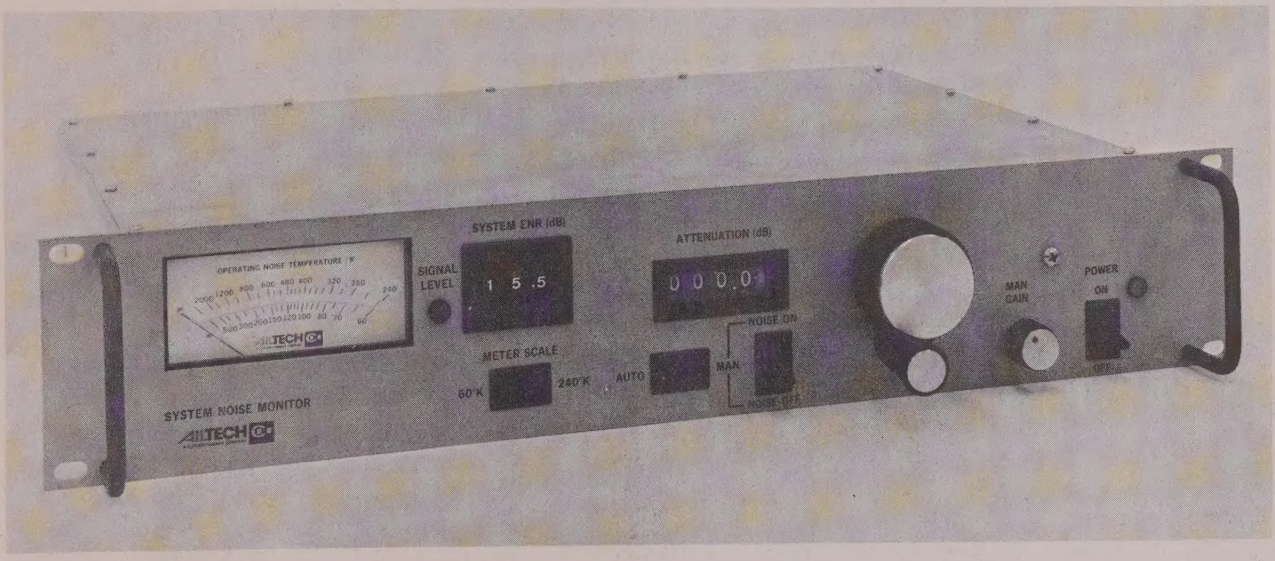
INSTRUCTION MANUAL FOR:

ANALOG
SYSTEM NOISE MONITOR

Part Number: 7330



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WARRANTY

Except for tubes, fuses and batteries which carry no warranty, Cutler-Hammer, in connection with equipment sold, agrees to correct any defect in workmanship or material which may develop during the period of one year from the date of shipment under proper or normal use and not in excess of the original manufacturer's life expectancy ratings, by its option to repair or replace, FOB point of shipment, the defective part or parts, and such correction shall constitute a fulfillment of all Cutler-Hammer liabilities in respect to said apparatus.

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5.3 CALIBRATION PROCEDURES

The sensitivity adjustment capability was incorporated in the SNM by using a 100 ohm potentiometer in place of R104. To make this adjustment connect an HP608 or equivalent signal generator to the IF Input of the SNM. Set S101 in the AUTO position. Set the generator to band center and to -80 dBm. Adjust the potentiometer until the SIGNAL LEVEL lamp goes out. Gradually adjust the potentiometer until the SIGNAL LEVEL lamp comes on. Set the signal generator to -81 dBm. The SIGNAL LEVEL lamp should go out.

REPLACEABLE PARTS

IF VIDEO BOARD ASSEMBLY
30 MHz and 70 MHz, 298020

Item	Description	Manufacturer	Part Number
R104	*Resistor, Var., 100 ohms	Weston	502-00S-100
	*Inductor, 0.33 uH	Delevan	1025-08

Note: In place of R106 the 0.33 uH inductor is installed.

* Used on 70 MHz Board Assembly #298020-2.

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I. INTRODUCTION

1.1 GENERAL

The AILTECH 7330 System Noise Monitor is a fully automatic instrument that provides a continuous indication of the noise performance of a microwave receiver. Its high accuracy and ease of operation makes it ideally suited for permanent installation in receiver systems.

All AILTECH solid state noise sources from 10 MHz to 18 GHz are useable with the AILTECH 7330.

1.2 SAFETY PRECAUTIONS

The AILTECH 7330 SNM is a low power instrument and should be completely safe, even to the untrained user. Care need only be taken when the unit is opened for service and a possibility of contacting line voltage exists. However, even this potential hazard is reduced by covering all exposed contact points with shrink tubing.

A three-wire, polarized line cord is supplied with the instrument and mates with an internationally accepted EMI/RFI line filter. The connector complies with all current and proposed requirements for commercial test equipment, both domestically and internationally.

Because of the continuous third wire ground, both sides of the line are fused for extra protection.

All exposed metal parts are at ground potential.

1.3 SPECIFICATIONS

Input Frequency Range	70 MHz
Bandwidth	10 MHz (nominal)
Sensitivity	-52 dBm (at IF Input)
Signal Level Range	40 dB
Input Impedance	75 ohms
Accuracy	Full Scale to Half Scale ±5.0% (in Kelvin) Half Scale to Quarter Scale ±8.0% (")
Calibration Range	System ENR of -5 to + 4.9 dB Optional 6 to 15.9 dB
Connectors	
IF Input	BNC, female
Noise Source	BNC, female +28.00 VDC for Noise On; 0 VDC for Noise Off
Output (all options)	Amphenol 57-20240-1
Recorder Output	1.0 VDC Full Scale into 1.0KΩ
Signal Monitor	6.0 VDC max. (non-linear)
Alarm Option	100V, 0.1A, SPDT relay de-energizes at variable threshold
External Meter Option	100 microamps F.S.
Power Input	115/230 VAC ± 15% 50/60 Hz, 10 watts
Operating Temperature	5-50°C
Weight	15 lbs. (6.8 kg) net 19 lbs. (8.7 kg) shipped

SPECIFICATIONS con't.

Size

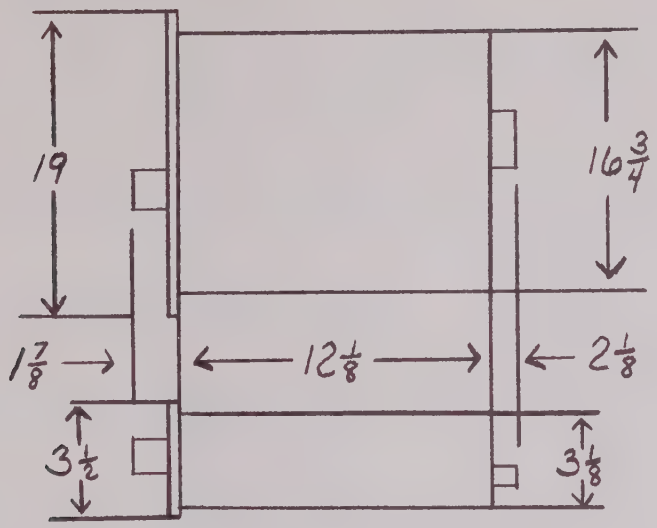


FIGURE 1-1 Overall Dimensions

II. INSPECTION AND INSTALLATION

2.1 UNPACKING AND DAMAGE CLAIMS

Your AILTECH 7330 System Noise Monitor is ready for use immediately upon receipt. Make the following checks, however, to assure that no damage has occurred during shipment.

2.1.1 Inspect the shipping container prior to acceptance from the carrier. Note any damage to the shipping container on the carrier's receipt.

2.1.2 Inspect the instrument for damage. Check for dents, scratches, broken switches, connectors, etc.

2.1.3 Remove the top and bottom covers and inspect for broken components or loose hardware.

2.1.4 If damage is not apparent until after the instrument has been accepted, file a claim for concealed damage with the carrier within 15 days after receipt. All packaging material must be kept for inspection by the carrier's agent. A copy of the claim must be forwarded to AILTECH.

2.2 POWER REQUIREMENT

The AILTECH 7330 may be operated from either 115 or 230 V power lines. Normally, all units sold for use in the USA and Japan will be set for 115 VAC; and all units for Europe will operate at 230 VAC. However, any unit may be switched from one voltage to the other by means of a switch located on the rear panel.

2.3 PRELIMINARY OPERATIONAL CHECKOUT

This operational checkout is a preliminary test and is not intended to confirm performance specifications. For complete Specification Validation Procedure, refer to section 5.

2.3.1 The equipment required for this operational checkout is:

a. Oscilloscope - Tektronics 531 (or equivalent)
b. Signal Generator - HP 608C (or equivalent)

2.3.2 To perform the checkout, proceed as follows:

a. Insert the power cord into a 3-wire 115/230 volt, 50-400 Hz, single phase power line outlet. Check LINE switch on rear panel for the appropriate applied voltage.

b. Throw the power switch to the ON position and observe that the red power light turns on.

c. The AUTO-MAN and NOISE ON/OFF switches and also the MANUAL GAIN potentiometer are located on the IF Video Board. If the 10 option is incorporated, these controls are located on the front panel. To find the switches and potentiometer refer to the IF Video Board pictorial for S101, S102 and R140 respectively. Set AUTO-MAN switch to the AUTO position and NOISE ON/OFF switch to the OFF position.

d. Connect a signal generator to the IF input on the rear panel of the AILTECH 7300. Set the frequency of the signal generator to the center frequency of the IF and the power to less than -100 dBm.

e. Increase power from signal generator to rated sensitivity as given in Section 1.3 Specifications, and observe that the Signal Level lamp on the front panel comes on.

f. Set AUTO-MAN switch to the MAN position. Observe that the Signal Level lamp turns off.

g. Set the RANGE switch located on the front panel to the LOW position. Rotate potentiometer MANUAL GAIN in the CW direction for maximum gain.

h. Increase the power from the signal generator until the meter reads full scale.

i. Rotate the MANUAL GAIN CCW and observe that the meter reading can be controlled to indicate a higher noise figure or noise temperature.

j. Connect the oscilloscope to the Noise Source connector on the rear panel of the AILTECH 7300. Set the NOISE ON/OFF switch to the OFF position. Observe that the output is close to ground potential.

k. Set NOISE ON/OFF switch to the ON position and observe that the output goes to 28 VDC.

l. Set the NOISE ON/OFF switch back to the OFF position and the AUTO-MAN switch to the AUTO position. Observe that the output is an approximate square wave, oscillating between ground and 28 VDC at about 285 Hz rate.

m. Leave switches in AUTO and OFF position.

If the instrument fails during any portion of the operational checkout, notify your local AILTECH representative immediately. The representative will arrange the repair or replacement of your instrument at the earliest possible moment.

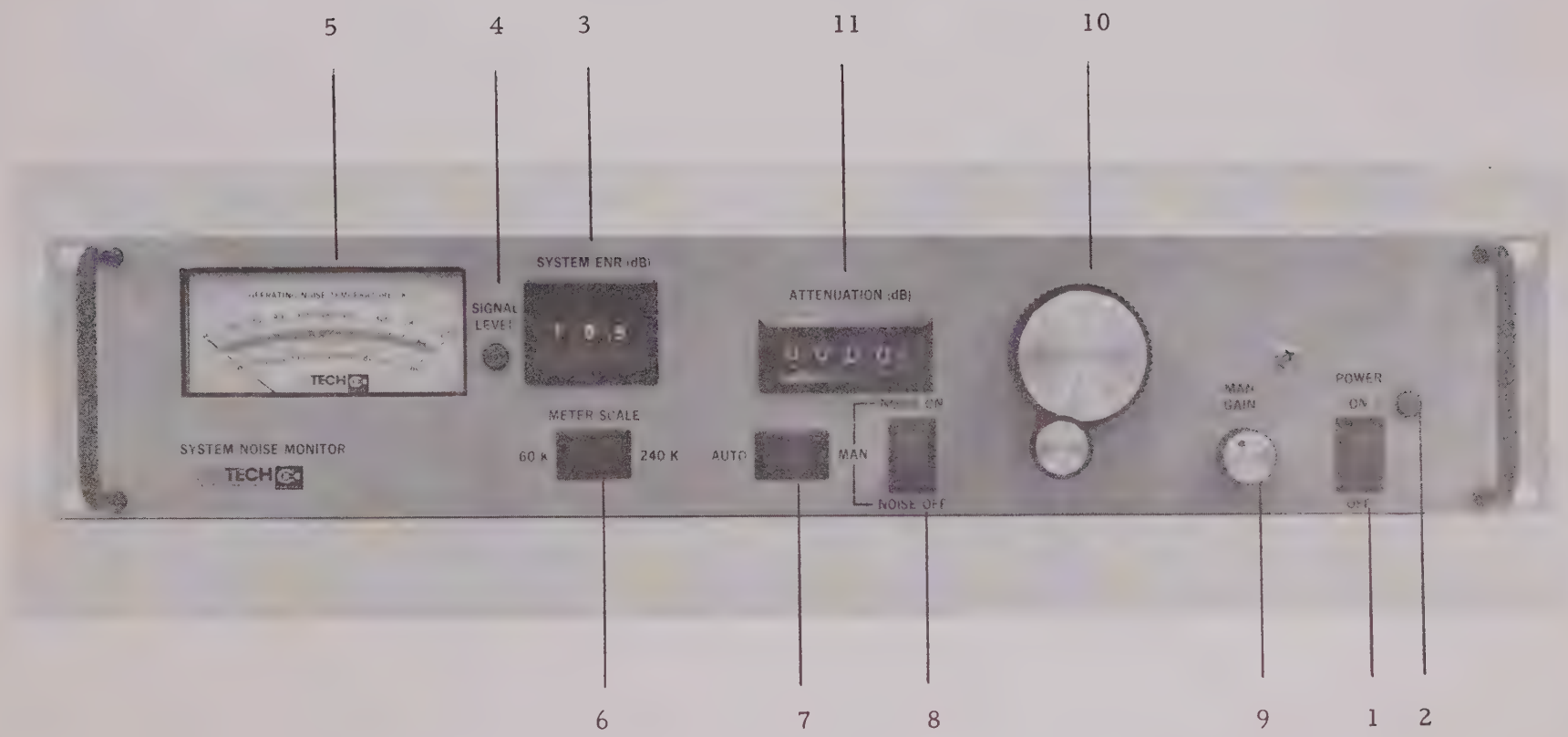


FIGURE 3-1 View of Front Panel

III. OPERATING INSTRUCTIONS

3.1 OPERATING CONTROLS

3.1.1 Front Panel

1. Power Switch (S1) - Controls the application of the primary AC power.

2. Power Lamp - Lights red when the instrument is turned ON.

3. System ENR Thumbwheel Switch (S3) - Calibrates the instrument to a known ENR at the input of the receiver under test.

4. Signal Level Lamp - Lights green when the IF input signal is above the minimum level.

5. Meter - Indicates Operating Noise Temperature (or Noise Figure in dB).

6. Meter Scale (S2) - Selects desired range.

7. Auto-Man Switch (S5) - Selects normal operational mode (AUTO) or calibration mode (MAN).

8. Noise On/Noise Off Switch (S4) - Controls noise source operation in the MAN mode.

9. MAN Gain Adjust - Controls the IF gain in the MAN mode.

10. Piston Attenuator Adjustment - Controls the amount of IF attenuation from a minimum of 18 dB insertion loss to a maximum of 118 dB.

11. Attenuation Readout - Displays the amount of attenuation in excess of the insertion loss.

3.1.2 Rear Panel

1. Fuses - 1/4A at 115 VAC and 1/8A at 230 VAC. Provides overload protection.

2. 115-230 Switch - Locking switch enables operation from either 115 or 230 VAC power lines.

3. AC Input - Line filter for primary AC power.

4. Output Connector (J1) - Interconnection junction for optional features: (Not used in this model).

5. IF Input (J8) - BNC Connector for IF signal from receiver under test.

6. Noise Source (J7) - BNC Connector for supplying excitation to solid state noise source.

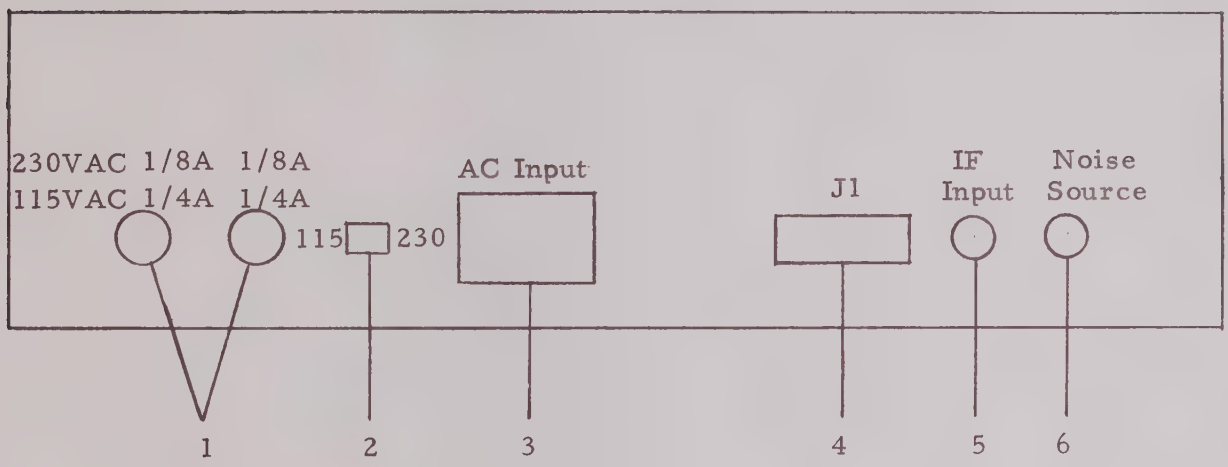


FIGURE 3-2 View of Rear Panel

3.2 OPERATIONAL PROCEDURES

1. Interconnect the equipment as shown in Figure 3.3

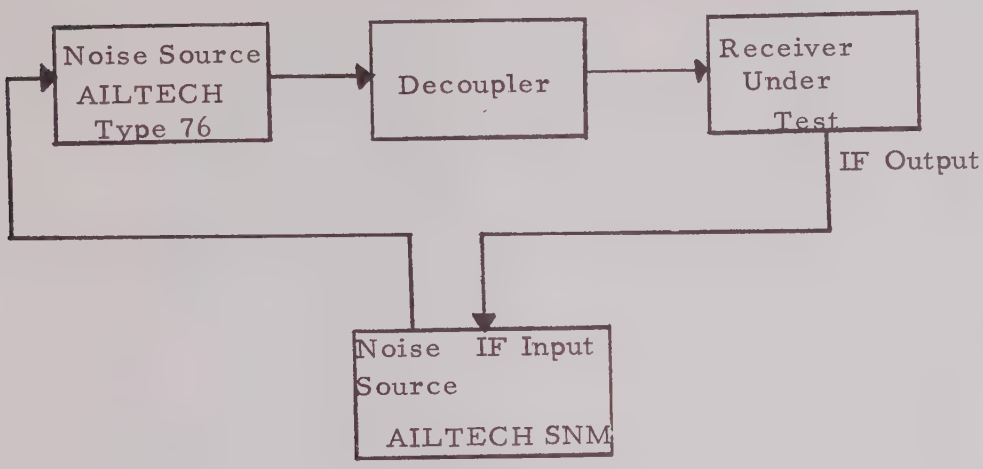


FIGURE 3-3 Typical Connection for Automatic Noise Figure Measurement

2. Subtract the amount of decoupling (in dB), including all the losses between the Noise Source and the receiver under test, from the calibrated value of ENR of the Noise Source. Insert this value into the AILTECH SNM via the System ENR thumbwheel switch.

3. Observe that the Signal Level indicator is on.

   Note: The AILTECH SNM has a linear dynamic range of 60 dB. For low noise figure measurements, (Y-factors of 10-15 dB), accurate readings will be obtained when the IF signal level is not greater than +45 dB above the minimum sensitivity.

4. Set the Meter Scale Switch in the position that will produce a reading on the upper half of the scale.

5. Read the Operating Noise Temperature (or Noise Figure) from the front panel meter.

IV. THEORY OF OPERATION

4.1 GENERAL THEORY

4.1.1 Noise Figure Theory - General

Noise Figure can be defined as the ratio of the noise power available at the output of a network, when the input termination is at the standard reference temperature (T_o = 290K), to that which would be available at the output of an ideal noise-less network of otherwise identical characteristics. This can be expressed mathematically as:

$$F = \frac{N_o}{GN_i} \tag{4-1}$$

By rearranging equation 4-1,

$$N_o = N_i F G \tag{4-2}$$

The noise power available at the input is that generated by the input termination and can be written as:

$$N_i = kT_oB \tag{4-3}$$

where:

k = Boltzmann's constant = 1.38×10^{-23} joules/K
B = bandwidth in Hz
T_o = standard reference temperature (290K)

NOTE

All temperatures in these equations are expressed as absolute temperatures (degrees Kelvin) and are related to the Centigrade scale as follows:

$$K = {}^{o}C + 273$$

Substituting in equation 4-2,

$$N_o = kT_oBFG \tag{4-4}$$

Expansion of this relation yields:

$$N_o = \left[kT_oB + (F-1)\, kT_oB\right] G \tag{4-5}$$

Although equation 4-5 expresses noise figure implicity in terms of its effect on the network output, it is sometimes considered more basic than equation 4-1 because:

- It can be used to show the effect of an input termination temperature differing from the reference temperature (T_o).
- It can be conveniently represented pictorially.
- It provides the basis for an indirect, but convenient, method of measuring noise figure.

Figure 4-1A is a representation of equation 4-5. Noise source A is the input termination. In addition, noise source B is a fictitious source that represents the network's contribution to the noise output, referred to the input. It should be noted that the definition of noise figure is based on the reference temperature. The effect of varying input termination temperature was discussed previously.

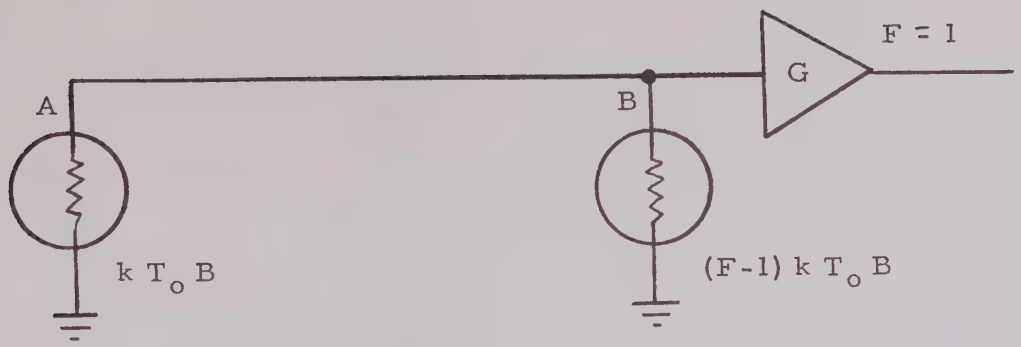
4.1.2 Noise Figure Measurement (General)

Figure 4-1A can be modified as indicated in Figure 4-1B. A switch is added, so that the original input termination (A) can be disconnected and the network input terminated in a second source (C) at a temperature T_2 (the temperature of the noise generator). The available output power of the network for this condition is:

$$N_o = \left[kT_2B + kT_oB\,(F-1)\right] \quad G \tag{4-6}$$

Dividing equation 4-6 by equation 4-4 yields:

$$\frac{N_{o2}}{N_{o1}} = \frac{T_2 + T_o\,(F-1)}{T_oF} \tag{4-7}$$



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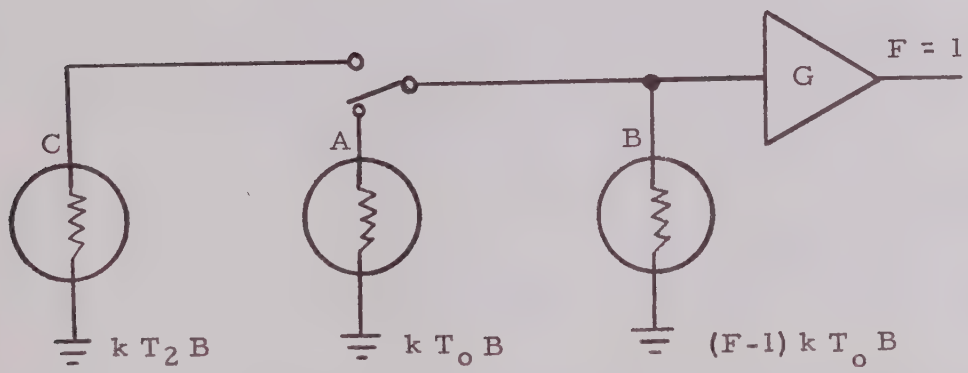
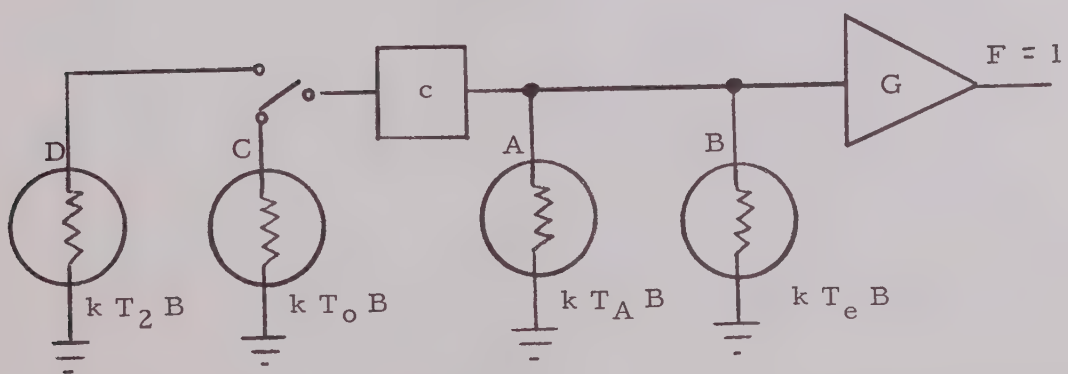


B.



C.

FIGURE 4-1 EQUIVALENT NOISE REPRESENTATION OF A NOISY NETWORK

Adding -1 to both sides and rearranging terms,

$$F = \frac{\left(\frac{T_2}{T_o} - 1\right)}{\left(\frac{N_{o2}}{N_{o1}} - 1\right)} \qquad (4\text{-}8)$$

Equation 4-8 is the basic relation for determing noise figure. The term T_2/T_o-1 is called excess noise ratio and is usually expressed simply as ENR. It represents the relative increase in noise power, at the network input when the switch is operated. If ENR is known, the ratio N_{o2}/N_{o1} (commonly called Y-factor) can be measured and the noise figure computed from equation 4-8. Note that it is not necessary to measure the absolute power levels at the network output, merely their ratio.

Therefore,

$$F = \frac{ENR}{Y-1} \qquad (4\text{-}9)$$

4.1.3 Operating Noise Figure Measurement (General)

In those applications where it is not possible to separate a standard termination from a termination with known ENR, a different measurement must be taken. An operating radar system is an example. In this type of system, a front-end performance factor (operating noise figure) is measured. Since it is very difficult to separate system noise from the antenna or receiver input generated noise, the two are lumped together and measured. Figure 4-1C indicated this technique.

The available output noise power from the network under operating conditions is given by:

$$N_o = \left[k(cT_o + T_a + T_e)B\right] \quad G \qquad (4\text{-}10)$$

When the reference noise source is energized (switch connected to D), the available output noise is:

$$N_o = \left[k(cT_2 + T_a + T_e)B\right] \quad G \qquad (4\text{-}11)$$

Dividing equation 4-11 by equation 5-10 yields:

$$\frac{N_{o2}}{N_{o1}} = \frac{cT_2 + T_a + T_e}{cT_o + T_a + T_e} \qquad (4\text{-}12)$$

Adding -1 to both sides and rearranging terms,

$$Y\text{-}1 = c(T_2 - T_o)/cT_o + T_a + T_e \qquad (4\text{-}13)$$

In equation 4-13, the term cTo in denominator represents that portion of noise coupled into the system from the noise source when it is de-energized. In most radar systems, the noise source is decoupled by at least 20 dB and therefore, the term represents an insignificant noise contribution and can be disregarded. Realizing that $(T_2 - T_o)/T_o$ is the ENR of the reference noise source and $(T_a + T_e)$ is the operating noise temperature and the operating noise figure (F_o) is $(T_a + T_e)/T_o$, we can rearrange terms in equation 4-13 to obtain:

$$F_{op} = cENR/Y\text{-}1 \qquad (4\text{-}14)$$

This relation has the same basic form as equation 4-9. The quantity cENR represents the power available from the system noise source at the receiver input.

4.1.4 Operating Noise Temperature Measurement

Referring to equation 4-13 and writing $T_a + T_e$ as the operating noise temperature T_{op}, we have:

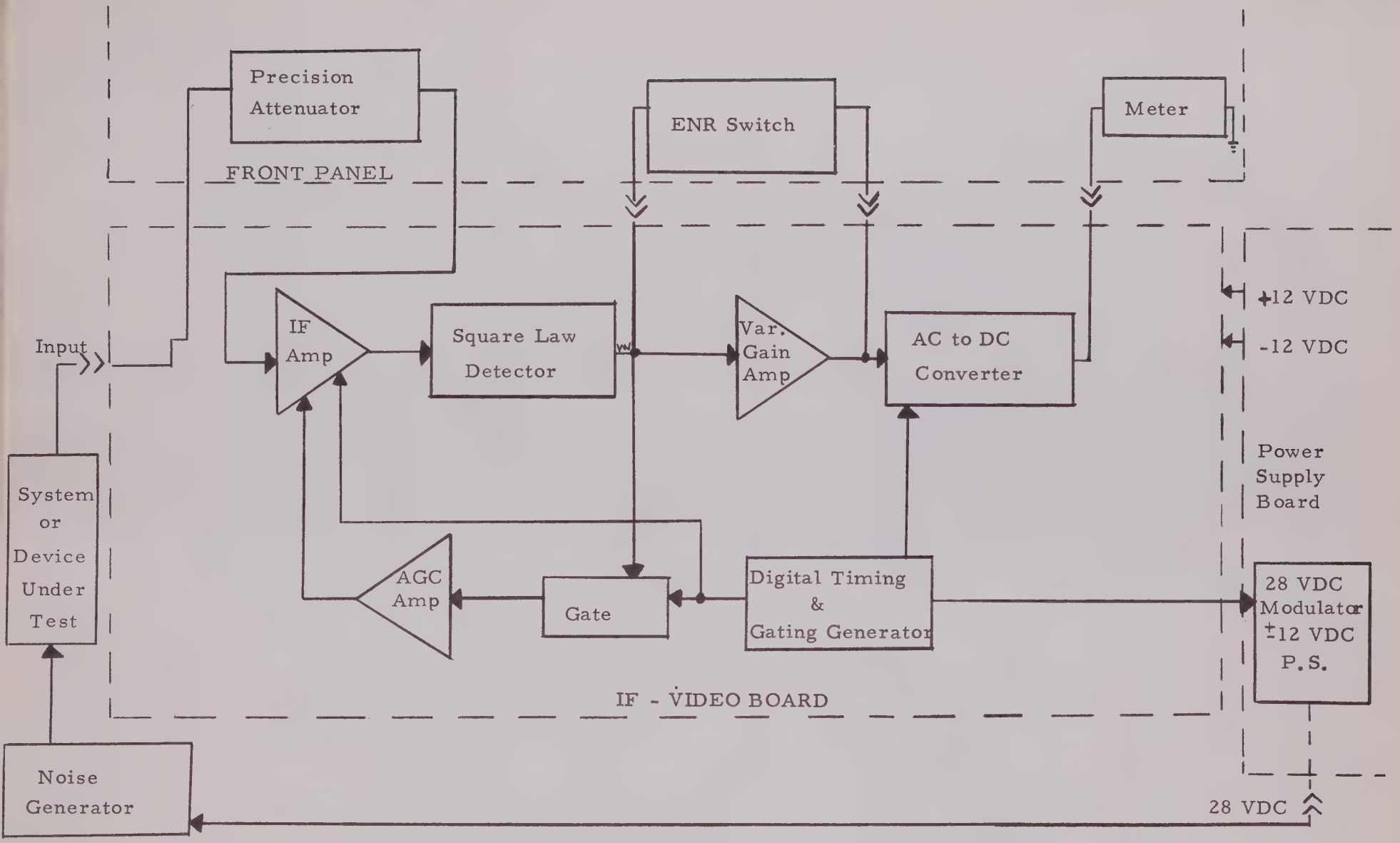
$$Y\text{-}1 = c(T_2 - T_o)/cT_o + T_{op} \qquad (4\text{-}15)$$

Neglecting cTo once again and rearranging as above, we can solve for T_{op}:

$$T_{op} = \frac{cENR \quad T_o}{Y\text{-}1} \qquad (4\text{-}16)$$

or:

$$T_{op} = F_{op} \; T_o \qquad (4\text{-}17)$$



BLOCK DIAGRAM FOR AUTOMATIC OPERATION

FIGURE 4-2

4.2 INSTRUMENTATION THEORY

4.2.1 Automatic Noise Figure Measurements

The basic elements of the SNM are shown in block diagram form in Figure 4-2.

A square wave generator, operating at approximately 400 Hz, modulates the DC power source for the Noise Generator, alternately energizing and de-energizing this unit. The resulting two noise levels are fed into the System under test. The IF output of the System will also be two levels of noise where the lower level represents the System noise when its input is terminated in its characteristic impedance at room temperature. The higher level is the System noise plus the Generator noise.

These signals are further amplified by the IF amplifier in the SNM. They are then detected by a square law device which outputs two voltages that are proportional to the noise powers in the IF signal.

A sample of this detected signal is supplied to an AGC amplifier that is gated to provide an output only during the time the noise generator is turned off. This output is used to control the gain of the IF amplifier, so that the noise-off signal is maintained at a constant level.

The above procedure may be described mathematically as follows:

Let the noise-on voltage at the output of the square law detector be $V_2 = pN_2$ and the noise-off voltage, $V_1 = pN_1$, where:

p = proportionality constant
N_1, N_2 = noise power

The difference between these voltages is indicated by the panel meter.

$$Vm = V_2 - V_1 \tag{4-18}$$

or:

$$Vm = p(N_2 - N_1) \tag{4-19}$$

Rearranging terms, $Vm = pN_1\left(\frac{N_2}{N_1} - 1\right)$ (4-20)

From the previous discussions:

$$\frac{N_2}{N_1} = Y \quad (4\text{-}21)$$

Therefore, $Vm = pN_1(Y-1)$ (4-22)

From Equation

$$Vm = pN_1 \quad \frac{ENR}{F} \quad (4\text{-}23)$$

Equation 4-23 indicates that, if ENR is known and N_1 is constant (a condition satisfied by the gated AGC amplifier), the meter voltage is inversely proportional to the noise figure of the device under test. This is a highly desirable result since lower noise figures read closer to full scale and thus greater resolution is achieved.

Note also that because a square-law detector is used, the meter scale, when calibrated in dB, becomes logarithmic, and thus produces a natural expansion on the upper half of the scale (where low noise figures are indicated).

4.3 CIRCUIT DESCRIPTION

4.3.1 General

The AILTECH 7330 System Noise Monitor is comprised of printed circuit boards as shown in the block diagram of Figure 4-2. All of the functional circuitry required to make a measurement is situated on the IF-Video Board. The second board contains only the regulated power supplies.

4.3.2 IF-Video Board

For the sake of clarity, this board will be discussed in sections corresponding to the blocks on Figure 4-2. Reference should also be made to the enclosed schematic diagram and to the parts list.

The IF Amplifier section of the board consists of two integrated circuit amplifiers, Z101 and Z102. Transformer coupling is used at the input of the first amplifier to achieve a good power match and a low noise figure. A voltage gain of about 6 dB is obtained in T101. C102 tunes the input network to the desired IF and establishes a nominal bandwidth of 10 MHz.

A further voltage gain of 6 dB is provided by Z101. This amplifier has an AGC input (pin 5) which is used to maintain the N_{off} signal at a constant level. The double ended design was selected to minimize interference from stray signals.

Amplifier Z102 boosts the signal by another 13 dB. Its AGC input is driven by a gating signal of approximately 100 microseconds width to establish a zero reference for comparing N_{on} and N_{off} levels. Z102 is coupled to the Square Law Detector by transformer T102 where an additional 6 dB of gain is realized.

*Note: The gain figures mentioned above are typical values only. Some variation is to be expected at the different intermediate frequencies. However, an overall gain of approximately 30 dB is required to achieve a sensitivity of -80 dBm.

The Square Law Detector, Z103, is a monolithic balanced modulator whose output contains a DC term proportional to the product of two input voltages. Since the input signals have three different amplitudes, zero reference, Noise On and Noise Off, the detector output will be a three level signal. Some low frequency (kHz) noise will also be present on the two noise signal levels. The exact waveform is shown in Figure 6-1, test point TP101.

An Analog Gate, Z110, is synchronized to pass only the zero reference and Noise Off detector levels into the AGC amplifier. This gate, as well as all the other gates used on this board, is a COS/MOS integrated circuit for compatability with the 12 volt power supply. Additional

advantages of high noise immunity and low power consumption are also realized.

AGC Amplifier is comprised of a series of gates and linear amplifiers whose function is the generation of a DC signal proportional to the Noise Off detector level. Additional circuitry was designed into this amplifier to fulfill the high gain requirement with AC signals, thereby eliminating any serious DC drift problems.

Z104 increases the Noise Off Amplitude by a factor of 75. Gates Z108 C and D pass this signal to the integrator, R131 and C134, where a DC level of 1 volt is obtained. Integration is required at this point to eliminate the low frequency noise modulation.

Conversion back to AC is achieved by chopping the signal with gates Z110 A and B. Differential amplifier Z111A compares this signal from Z109A against a similarly chopped 1 volt reference from Z109B. A gain of 100 is provided in this AC comparator. A final conversion to DC is made in C137 at the high impedance input of Z111B. The output of Z111B is the desired AGC voltage. It will vary from a minimum of about +5 VDC at threshold to +7 VDC at the limit of its range.

The Variable Gain Amplifier provides a means of changing the calibration of the instrument to accomodate changes in ENR as large as 9.9 dB. It is a two stage device consisting of Z105A and B. Each stage is operated in the inverting mode establishing a gain function that is directly proportional to the feedback resistor. The value of this resistor is controlled by the System ENR thumbwheel switch mounted on the front panel.

The gain of Z105A can be varied from 0 dB (1.00) for a System ENR of 15 to 9 dB (7.94) at a System ENR of 6 dB. Z105A is variable from 0 dB (1) at .9 Setting of System ENR to .9 dB (1.23) at .0.

The AC to DC Converter Because Noise Figure and Operating Temperature are functions of Y-1, a subtraction of $N_{on} - N_{off}$ is required. This subtraction is achieved by clamping the N_{off} signal to ground through Z106C and storing the N_{on} level in capacitor C131.

Operational amplifier Z107 is used as a linear current device to drive the meter. By varying the resistance between pin 7 (inverting input) and ground, the meter current can be readily adjusted. Therefore, potentiometer, R124, has been included in this path to provide an easy means of calibration (See Section 5).

Provision to drive an external meter is also supplied through amplifier Z117B. Resistor R165 is the scaling resistor and will normally be chosen to provide 100 microamps of meter current at full scale.

The Digital Timing and Gating Generator consists of three integrated circuit packages which provide the modulation signal for the noise generator and control the various analog gates.

The basic clock signal is generated by Z114A and B. R146 and C138 set the frequency at about 400 Hz. Z114 C squares the clock for gating and Z114D provides the inverse signal.

A monastable multivibrator formed by Z115A and B develops a 200 microsecond pulse at every clock transition. These narrow pulses are used to gate the second IF amplifier, Z102, and establish the zero reference for AGC.

N_{on} gates Z115C and Z116A combines the above waveforms into further gating signals. The exact timing and waveshapes are given in Figure 6-1.

4.3.3 Power Supply Board

The AILTECH 7330 is a low power instrument requiring only three different DC voltages: +12 VDC at 200 mA, -12 VDC at 50 mA and +28VDC at 20 mA. All three voltages are derived from individual monolithic regulators and are protected by current limiting resistors.

The +12 volt output from Z201 is set by resistors R204, R205 and R206. R205 is made adjustable because the +12 volt supply is used to set certain threshold levels on the IF-Video Board. Its short circuit current is determined by R201. C203 is a compensation capacitor and C204 acts as a noise filter.

The -12 volt supply is regulated by Z202. Resistors R207 and R208 determine this exact value of the regulated output. It may vary from -11.8 VDC to -12.2 VDC. The short circuit current is

determined by R209. C208 is the compensation capacitor and C207 filters the noise.

The + 28 volt supply is regulated by Z203. A remote shutdown feature is designed into this supply to permit modulation by the 400 Hz clock on the IF Video Board. Transistor Q202 provides this capability. The 28 volt output can be precisely set by R215. R212 provides the short circuit protection.

V. OPERATIONAL ADJUSTMENTS AND CALIBRATION PROCEDURES

5.1 GENERAL

This section contains the operational adjustment procedures and calibration procedures for the AILTECH 7330 SNM. The operational adjustments can have an affect on the accuracy of the instrument and should be performed carefully. A warm-up (stabilization) time of 15 minutes is recommended prior to performing the calibration adjustments.

The following test equipment is required: Signal Generator - HP 608A or equivalent, Digital Voltmeter and IF Preamplifier.

5.2 OPERATIONAL ADJUSTMENTS

5.2.1 12 Volt Power Supply

a. Connect the Digital Voltmeter between Test Point 202 and ground.

b. Adjust R205 for an indication of +12.00 ± .05 volts on the DVM.

c. Measure the voltage between TP204 and ground and observe that it is -12.00 ± 0.5 volts.

5.2.2 28 Volt Power Supply

a. Connect the DVM between Test Point 206 and ground.

b. Place front panel switch S5 in the MAN position.

c. Place front panel switch S4 in the ON position.

d. Adjust R215 for an indication of +28.00 ± .02 volts on the DVM.

e. Throw Switch 4 to the OFF position and note that the DVM indicates less than 0.2 volts.

5.2.3 Meter Zero

With S5 in the AUTO mode and no IF input, R150 is adjusted so that the meter reads down scale to infinity.

5.2.4 IF Amplifier

a. To align the input network , use a Vector Voltmeter and adjust C154 and C102 to obtain a reflection coefficient of 0.1. Note: SNM units with a piston attenuator permanently connected to the IF Video Board input, J10, requires no input impedance adjustment since the insertion loss of the piston attenuator predominates.

b. Connect a signal generator to the IF input; i.e., J10, the input to the IF Video Board, or J8, the input to the piston attenuator.

c. Put S5 in the MAN mode, and set the signal generator level and/or the MAN GAIN, R2, to obtain a midscale reading on the meter. Adjust C114 to maximize this reading.

d. Set S5 to the AUTO mode. Observe that the SIGNAL LEVEL light comes on. Adjust the signal generator attenuator until the light goes out; then slowly readjust until the light just comes on. This threshold point is the sensitivity of the AILTECH SNM 7330. Observe this sensitivity reading to be -80 dBm. With the piston attenuator connected, observe a -62 dBm reading.

If these values cannot be obtained, refer to Section 6.3.

5.2.5 Signal Monitor

a. Connect a DVM to pin 4 of J1 (rear panel) and a signal generator to the IF input, J8.

b. Set the signal generator to the threshold point, as described previously, and adjust R169 until the DVM reads 0.0 $\pm$ 0.05 volts.

c. Increase the signal generator level and observe the DVM reading increase to a maximum of approximately +6 volts for an input change of 50 dB.

5.2.6 Recorder Output

a. Connect a DVM to pin 8 of J1 (rear panel) and a signal generator to the IF Input, J8.

b. Set S5 to the MAN mode and adjust the signal generator level until the SNM meter reads full scale. Adjust R125 for a 1.0 ± 0.03 volt reading on the DVM.

c. Re-adjust the signal generator level until the SNM meter reads half scale. Observe the DVM reading 0.5 ± 0.06 volt.

5.3 CALIBRATION PROCEDURES

The accuracy of the AILTECH 7330 SNM is determined by comparing the measurement made in the automatic mode against a manual (Y-factor) measurement. The Manual measurement is made as follows:

a. With the equipment connected in the system and the noise source coupled to the receiver input, place the POWER switch in the ON position.

b. Set front panel S5 to the MAN position.

c. Set front panel S4 to the OFF position.

d. Adjust R2 (MAN GAIN) and the Precision Attenuator for a convenient reference reading (eg. 80^{o}) on the front panel meter.

Note: The gain of some Receiver may be too low to provide a satisfactory reference point. In this case, an additional IF amplifier can be inserted between the Receiver and the Precision Attenuator.

e. Throw S4 to the ON position.

f. Increase the Precision Attenuator setting until the AILTECH 7330 meter returns to the reference point of step d. The change in the Precision Attenuator is the Y-factor in dB.

g. Throw Switch S4 in the OFF position and return the Precision Attenuator to its original setting. Observe that the meter returns to its original reference point.

The Noise Temperature of the device can be computed from the following equation.

$$T_{op} = \frac{c\ ENR\ To}{Y-1}$$

where:

T_{op} = Operating Noise Temperature in kelvins.

c ENR = Excess Noise Ratio at the input of the unit under test. It is the actual noise source ENR times the coupling loss in the system as a ratio.

Y = Change in the Precision Attenuator corrected to a ratio.

To = Room Temperature in kelvins (approximately 290K).

h. After calculating the noise temperature, place the AILTECH 7330 in its Automatic mode and observe that it reads the calculated value.

Note: If an AILTECH Noise Slide Rule is available, the T_{op} can be obtained by setting the Y-factor (dB) under the ENR (dB). The latter is actually c ENR in dB.

i. If there is a difference, adjust R124 for calibrating the upper scale of the meter until the automatic measurement agrees with the manual results. For calibrating the lower scale of the meter, adjust R161 as required.

VI. MAINTENANCE AND TROUBLE SHOOTING

6.1 GENERAL

This section contains information pertaining to preventive and corrective maintenance.

It is recommended that the corrective maintenance be accomplished by replacement at the sub-assembly level. The AILTECH SNM has been designed for easy removal of printed circuit cards and front panel components. Substitution of sub-assemblies will reduce down time to minutes and allow even untrained personnel to perform the maintenance. A list of recommended spare subassemblies is given in Section VII.

6.2 PREVENTIVE MAINTENANCE

In general, no preventive maintenance, as such, is required. Occasional cleaning is recommended and can be accomplished in conjunction with routine calibration. A calibration cycle of three months is suggested for normal operating conditions.

6.3 CORRECTIVE MAINTENANCE - TROUBLESHOOTING

The first step in troubleshooting the AILTECH is to isolate the fault in one of the sub-assemblies. Test points are provided on the printed circuit cards to simplify this test.

When the unit malfunctions, and the problem cannot be corrected by following the Operational Adjustments and Calibration Procedures of Section V, continue with the following checks:

1. Verify that the Power Supply Board is functioning properly by observing the following voltages:

Test Point	DC Voltage	Ripple
201	+20	<800 mV
202	+12	< 5 mV
203	-20	<400 mV
204	-12	< 5 mV
205	+40	<200 mV
206	28 (MAN-ON)	<40 mV

If any of these waveforms are missing, or greatly distorted, replace the active unit (voltage regulator or rectifier bridge) immediately preceeding the appropriate test point. Those failures which are caused by a malfunctioning passive unit are considered to be negligibly small. Should a case arise it is best handled by returning the subassembly to AILTECH for repair.

2. The IF Video Board can be serviced most easily by using the Timing Diagram of Figure 6-1. Included with each typical waveform is a list of active elements which could cause a failure. Except as noted, the waveforms are the same in either the AUTO or MANUAL modes.

Auto Mode Waveforms - The waveforms shown are the results of testing an amplifier with a 4 dB noise figure using a noise diode with an ENR of 15.5 dB. For these values, the Y-factor is 11.8 dB which is a power ratio of approximately 15. The voltage ratio at TP101 is equivalent to this power ratio due to the square law detector.

The Noise Off level, as measured, is 25 mV above the Reference level. The Noise On level is 380 mV above the Reference level. The ratio of Noise On to Noise Off, therefore, is 380/25, which approximates the power ratio of 15.

Manual Mode Waveforms - The waveforms at TP101 and TP102 in the MANUAL mode are the results of testing the same amplifier with the same noise diode. At one setting of the MANUAL GAIN adjustment, the Noise Off level is 150 mV above the Reference level. The Noise On level is 2.3 V above the Reference level. The ratio of Noise On to Noise Off, therefore, is 2.3/0.15 which approximates the power ratio of 15.

Note: The amplitude of the waveforms are proportional to the manual gain setting.

a) For an incorrect waveform at TP101, replace Z101, Z102, Z103 or Z104. If these do not correct the problem proceed to the check of TP104. Because the AGC loop is closed in the AUTO mode, a malfunction anywhere in this loop could affect the output voltage.

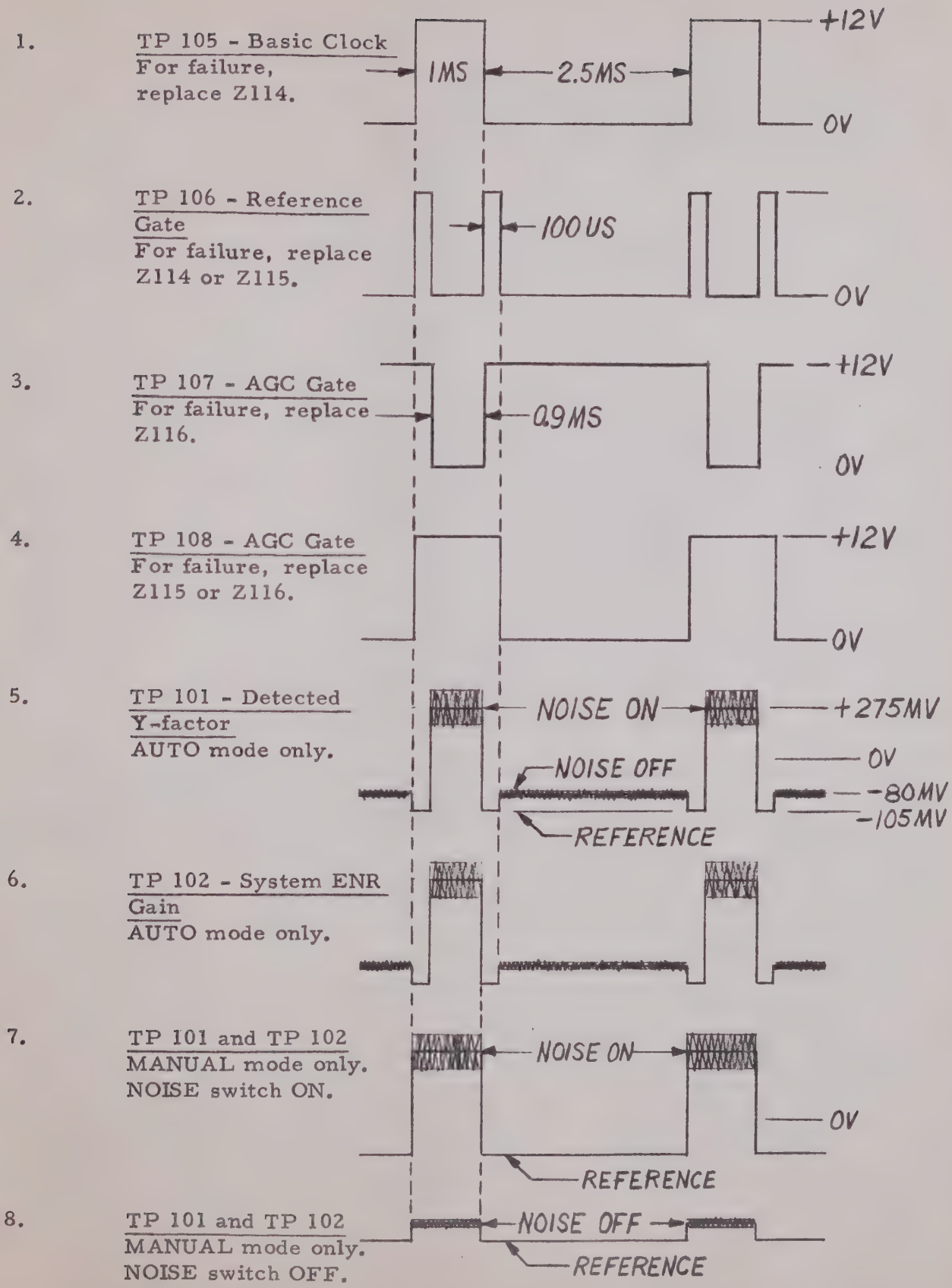


FIGURE 6-1 TIMING DIAGRAM

b) TP102 has the same waveform as TP101 amplified via the gain setting of the System ENR switch. For the given noise diode at a setting of 15.5, a condition of unity gain is established. As the numbers get smaller, the gain is increased proportionally; eg., at 12.5, the signal should be twice as large as that at 15.5. For failure, replace Z105.

c) TP103 - Meter Driver - DC Signal - 0.8 volts for full scale deflection of meter. For failure, replace Z106 or Z107.

d) TP104 - AGC Voltage - Between 5 and 7 volts.

At minimum sensitivity, approximately 5.5 volts.

Because of the high gain on this circuit, additional integrated circuit gates are provided to convert from DC to AC and back to DC again. Therefore, a failure at this point could be from any of the following: Z104, Z108, Z109, Z110, Z111, or Z112.

e) Signal Level Lamp - 12 volts DC Signal - If AGC level at TP104 is between 5 and 7 volts and Signal Level Lamp fails to light, replace Z113 or Q901.

Troubleshooting in more detail than above is not recommended. Unit should be returned to AILTECH for further repair.

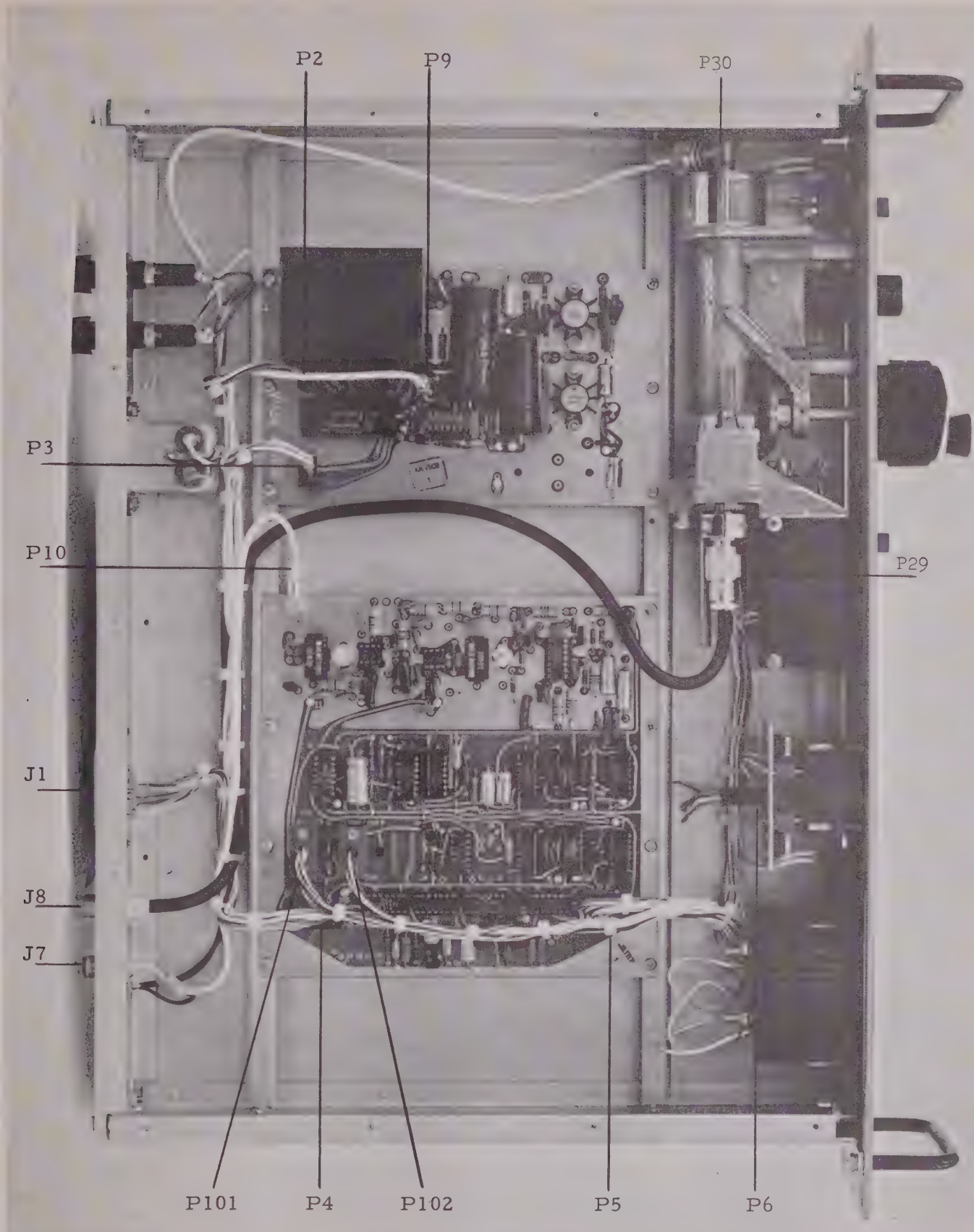


FIGURE 6-2 View of Cover Removed

VII. SPARE PARTS

7.1 GENERAL

The System Noise Monitor is designed to facilitate maintenance through the replacement of defective modules. All sub-assemblies are modularized and easily replaceable through design for accessibility and utilization of modern interconnecting hardware. Use of trouble shooting procedures and test points can easily identify faulty sub-assemblies.

7.2 RECOMMENDED SPARE PARTS

Based on reliability and maintainability aspects of design the following spare parts are recommended for stock at each site for a low quantity of System Noise Monitors:

Item	Description	Manufacturer	Part Number
	IF Video P.C. Board	(see enclosed parts list for number)	
	Power Supply P.C. Board	AILTECH	298021-1
	System ENR Gain P.C. Board	AILTECH	298172-1
S3	Switch, Thumbwheel	AILTECH	298800
M1	Meter	AILTECH	298254*
F1,2	Fuse, 1/8 Amp (230 VAC connection)	AILTECH	990019-4
	Fuse, 1/4 Amp (115 VAC connection)	AILTECH	990019-23
DL1	Lamp, Incandescent	Data Display	44-DD57-RO
DL2	Lamp, Incandescent	Data Display	44-DD57-GO
	Attenuator, Precision, 70 MHz, 75 ohms	AILTECH	003270
	Noise Source	AILTECH	7650*

* The part number will vary for option requirements.

7.3 REPLACEABLE SPARE PARTS

For connector housing service, use Connector Tool supplied by Amp, part number 91084-1.

Main Chassis

Item	Description	Manufacturer	Part Number
DL1	Lamp, Incandescent	Data Display	44-DD57-RO
DL2	Lamp, Incandescent	Data Display	44-DD57-GO
F1,2	Fuse, 1/8 Amp (230 VAC connection)	AILTECH	990019-4
	Fuse, 1/4 Amp (115 VAC connection)	AILTECH	990019-23
M1	Meter	AILTECH	298254
J1	Connector, Jack	Cinch	57-40240
P1	Connector, Plug	Cinch	57-30240
P2	Housing (4 Pin)	Amp	87133-4
P3,6	Housing (10 Pin)	Amp	87133-5
P4,5	Housing (20 Pin)	Amp	87133-6
J7	Connector		UG1094/U-1050
J8	Connector		UG910 B/U
P9,10	Coupling, Snap (plug)	Phelps-Dodge	700156
S1,4	Switch, Paddle (DPDT)	C&K Comp.	7201 J60
S2	Switch, Rocker (DPDT)	C&K Comp.	7201 J50
S3	Switch, Thumbwheel	AILTECH	298800
	Filter, RFI	Corcom	IEF1
	IF Video P.C. Board	(see enclosed parts list for number)	
	Power Supply P.C. Board	AILTECH	298021-1
S5	Switch, Rocker (4PDT)	C & K Comp.	7401-J1

REPLACEABLE SPARE PARTS (cont.)

Main Chassis (cont)

Item	Description	Manufacturer	Part Number
	Line Cord, 3 Conductor 6'	Corcom	80-1245
	Connector Tool	Amp	91084-1
	Handle, Brass, BL. Oxide	HH Smith	1621
	Attenuator, Precision 70 MHz, 75 ohms	AILTECH	003270
	Knob, Round	Raytheon	DS70-IBD-2G
	Knob, Crank	National	NPS17S2L-E
	Potentiometer, 1K	AILTECH	212106
P101, P102	Plug & Cable Assembly	Augat	1P16-4T24-1

IF VIDEO BOARD ASSEMBLY
30 MHz and 70 MHz - 298020

AIL Part No.	I.F.	Input	
*298020-1	30 MHz	50Ω	*Used on 298020-1
#298020-2	70 MHz	75Ω	#Used on 298020-2

Item	Description	Manufacturer	Part Number
C102, C154	Capacitor, Var. 15-60 pF	Erie	538-011-F15-60
C104, C105 C106, C108 C109, C110 C111, C112 C113, C115 C116, C118 C120, C122 C126, C128 C139, C140 C141	Capacitor, .001 uF	CRL	DD-102
C101, C119 C123, C132	Capacitor, .01 uF 50V		115285-6
C114	Capacitor, Var. 15-60 pF	Erie	538-011-F15-60*
C138	Capacitor, 2200 pF		CK06BX222K
C124, C125	Capacitor, 25 uF 16V	Sprague	TE1157.1
C136	Capacitor, 2.25 uF		CS13BE225K
C103, C127 C129, C130 C147	Capacitor, 0.1 uF 50V		115285-15
C131, C135	Capacitor, 10 uF 16V		115307-16
C133	Capacitor, .047 uF		115285-14
C134	Capacitor, 1 uF 16V	Sprague	TE1148
C150	Capacitor, 2 uF 25 WVDC	Sprague	TE1201
C137	Capacitor, 50 uF 16V	Sprague	TE1160

Item	Description	Manufacturer	Part Number
CR101	Diode, Zener		IN936
CR102	Diode		IN4009
J10	Coupling Snap	Phelps Dodge	7002 14
C143	Capacitor, 10pF		CK05CW100K
C114	Capacitor, Var. 1.9-15.7 pF	E.F. Johnson	187-0109-005#
R169	Resistor, Var., 2K	Weston	502-00S-2K
L101, L102 L103, L104 L105, L106 L107, L108 L109, L110 L111	Inductor 14 uH	Delavan	115297-2
R101	Resistor, 100Ω1/4W		RC07GF101J*
R102	Resistor, 5.1K 1/4W		RC07GF512J
R153, R154	Resistor, 5.1Ω1/4W		RC07GF5R1J*
R141	Resistor, 1.2K 1/4W		RC07GF122J
R172, R105 R110, R147 R148, R166 R151, R162 R163	Resistor, 10K 1/4W		RC07GF103J
R104	Resistor, 20Ω1/4W		RC07GF200J*
R111, R136, R138, R145	Resistor, 1K 1/4W		RC07GF102J
R108, R109	Resistor, 6.2K 1/4W		RC07GF622J
R112, R113	Resistor, 3.9K 1/4W		RC07GF392J
R114, R116 R165, R130	Resistor, 10K 1% 1/8W		RN60C1002J

Item	Description	Manufacturer	Part Number
R115, R117 R137	Resistor, 100K 1/4W		RC07GF104J
C117, C121	Capacitor, 470 pF		DM 15-471J
R160, R118 R120, R119 R121	Resistor, 1K 1/8W 1%		RN60C1001F
R123	Resistor, 5.49K 1% 1/8W		RN60C5491F
R157, R124 R161	Resistor, Var. 5K	Weston	502-00S-5K
R122, R171	Resistor, 7.5K 1/4W		RC07GF752J
R125	Resistor, Var. 20K	Weston	502-00S-20K
R131, R167	Resistor, 51K 1/4W		RC07GF513J
R127	Resistor, 7.50K 1% 1/8W		RN60C7501F
R128	Resistor, 300Ω1% 1/8W		RN60C3000F
R129	Resistor, 80.6K 1% 1/8W		RN60C8062F
R134, R135	Resistor, 20K 1% 1/8W		RN60C2002F
R143	Resistor, 8.2K 1/4W		RC07GF822J
R142, R144	Resistor, 4.3K 1/4W		RC07GF432J
R140	Resistor, Var. 1K	Weston	502-00S-1K
R139	Resistor, 1.6K 1/4W		RC07GF162J
R150	Resistor, Var. 10K	Weston	502-00S-10K
R126, R132 R133	Resistor, 100 1%1/8W		RN60C1000F
R168	Resistor, 510 1/4W		RC07GF511J#
R146	Resistor, 820K 1/4W		RC07GF824J

Item	Description	Manufacturer	Part Number
R149	Resistor, 200K 1% 1/8W		RN60C2003F
T101	Transformer	Magnetico	298730*
	Socket IC (8 Pin)	Texas Inst.	C930810
	Socket IC (14 Pin)	Texas Inst.	C931410
	Socket IC (16 Pin)	Texas Inst.	C931610
T102	Transformer	Magnetico	12419*
T102	Transformer	Magnetico	12420#
Z101, Z102	Integrated Circuit	Motorola	MC1350P
Z103	Integrated Circuit	Motorola	MC1496L
Z104, Z105 Z107, Z109 Z111, Z113 Z117	Integrated Circuit	Signetics	UA747CA
Z106, Z108 Z110, Z112	Integrated Circuit	RCA	CD4016AE
Z114	Integrated Circuit	RCA	CD4049AE
Z115, Z116	Integrated Circuit	RCA	CD4000AE
S101, S102	Switch		DS16A4-2
Q101	Transistor		2N4123
	Post	Amp	86091-2
K101	Relay	Grigsby-Barton	GB835C**
T101	Transformer	Magnetico	12539#
R164	Resistor, 6.04K 1%		RN60C6041F
R170	Resistor, 4.02K 1%		RN60C4021F

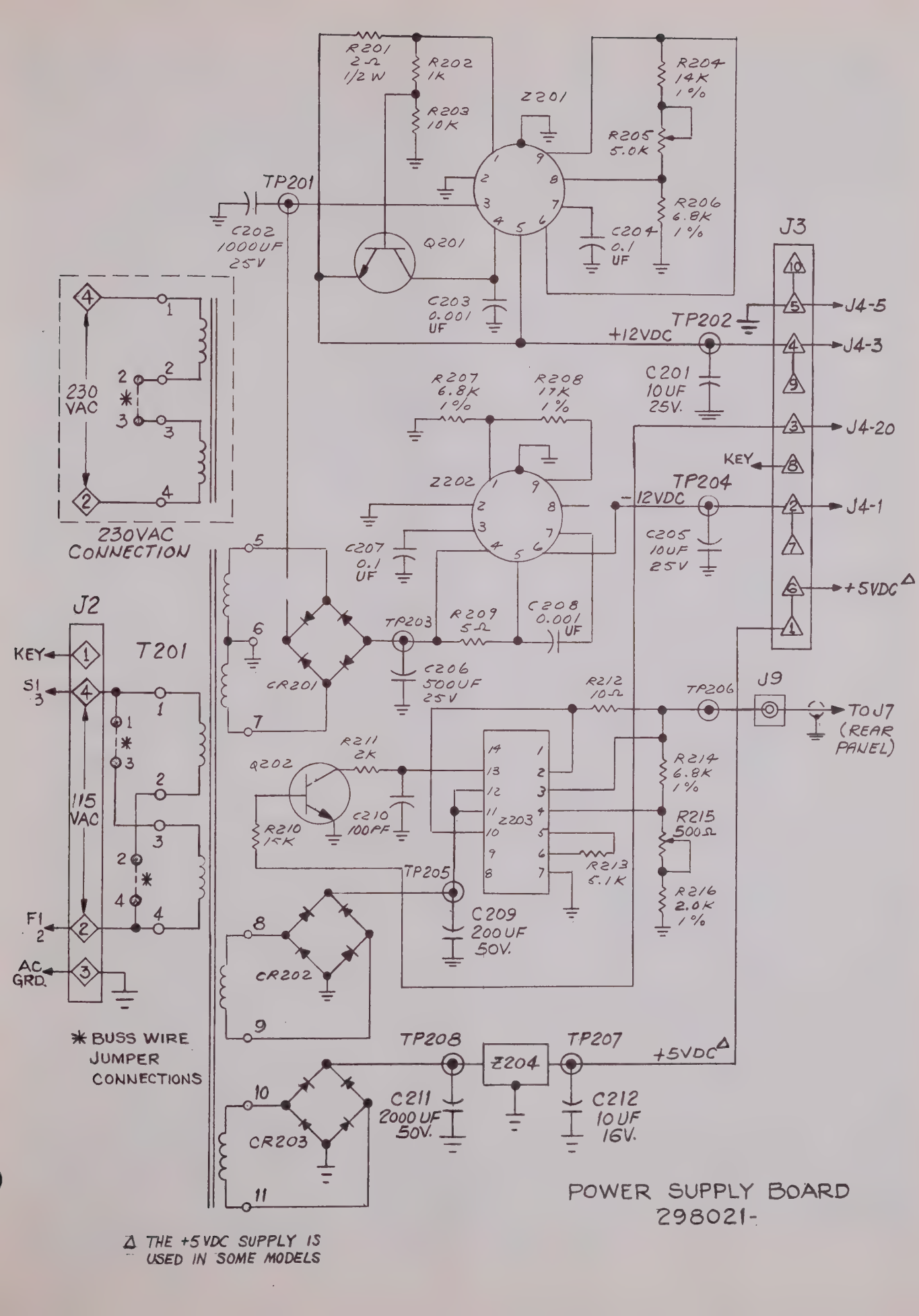
** Part used on the Alarm Option.

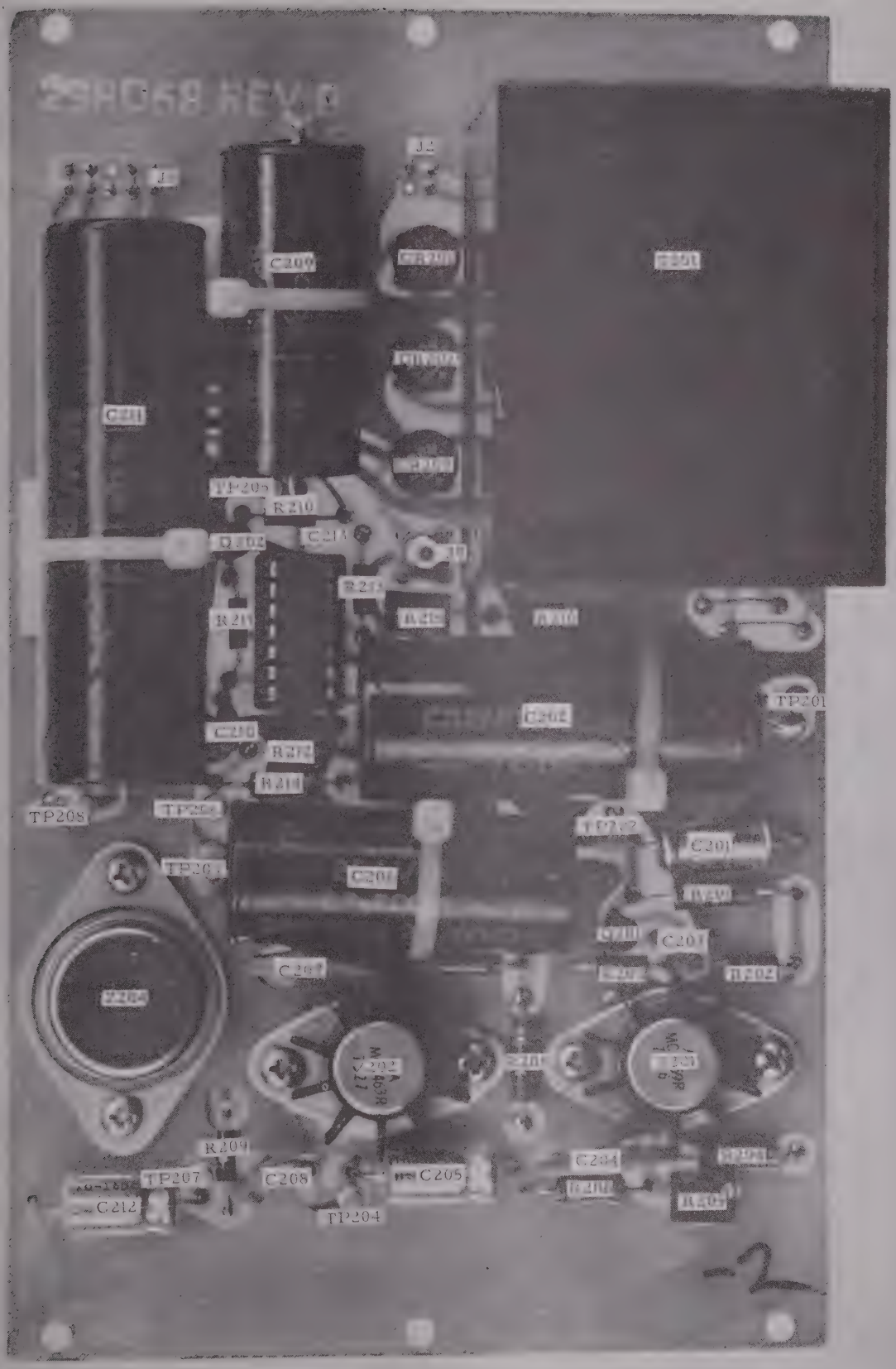
Item	Description	Manufacturer	Part Number
R168	Resistor, 1K 1/4W		RC07GF102J*
R106	Resistor, 510Ω1/4W		RC07GF511J*
R106	Resistor, 1K 1/4W		RC07GF102J#
R104	Resistor, 62Ω1/4W		RC07GF620J#
R173, R174	Resistor, 82.5K 1%		RN60C8252F
Q102	Transistor		2N4125
R152	Resistor, 1 MEG 1/4W		RC07GF105J
R158	Resistor, 2.2K 1/4W		RC07GF222J
R159	Resistor, 3.0K 1/4W		RC07GF302J
R153, R154	Resistor, 15Ω1/4W		RC07GF150J#

POWER SUPPLY BOARD ASSEMBLY

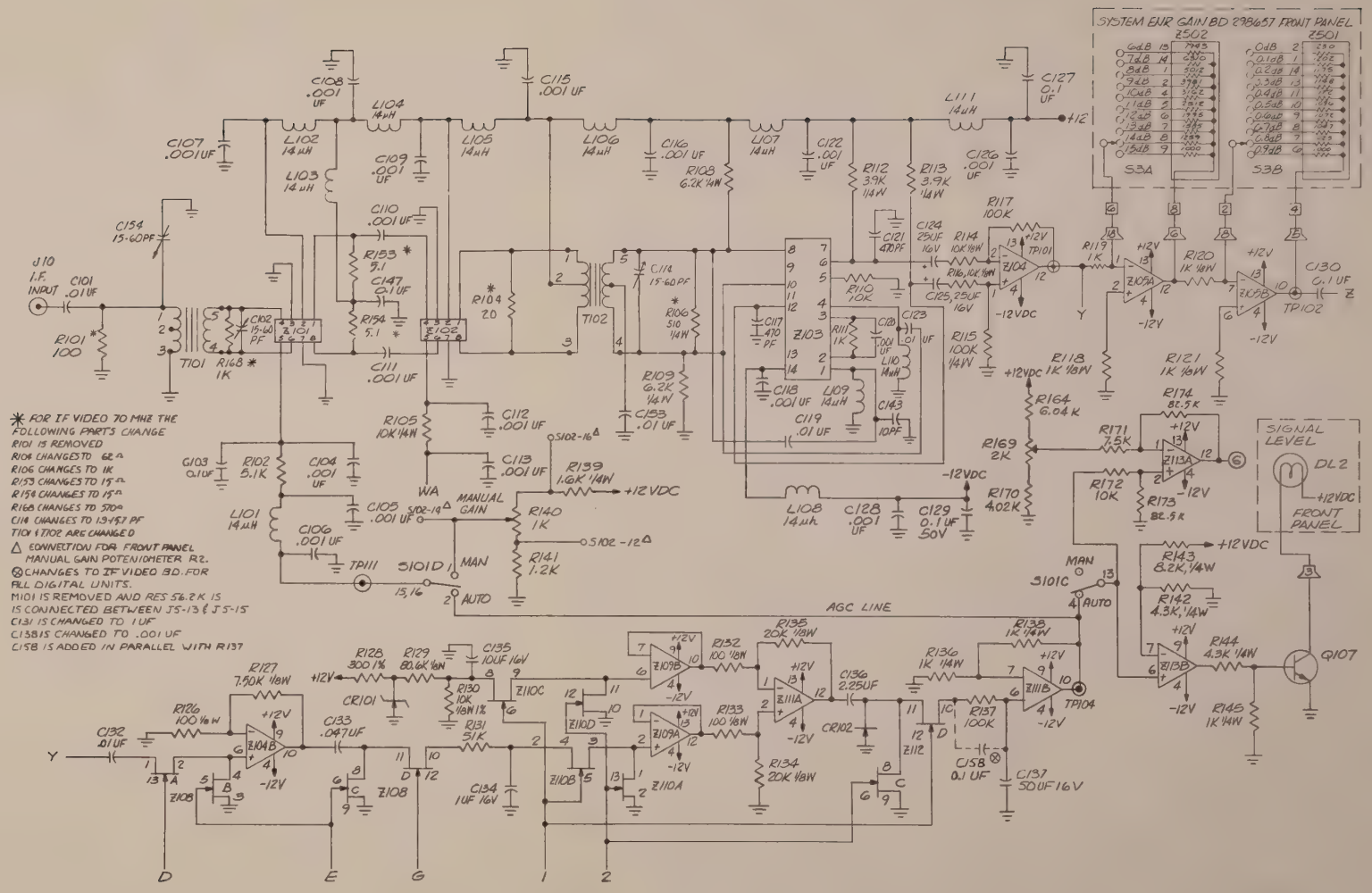
Power Supply Board Assembly - P/N 298021-1

Item	Description	Manufa cturer	Part Number
C201, C205	Capacitor, 10 uF, 16V	AILTECH	115307-16
C202	Capacitor, 1000 uF, 25V	C-D	BR1000-25
C203, C208	Capacitor, .001 uF	CRL	DD-102
C204, C207	Capacitor, 0.1 uF	CRL	DDA-104
C206	Capacitor, 500 uF, 25V	C-D	BR-500-25
C209	Capacitor, 250 uF, 50V	C-D	BR-250-50
C210	Capacitor, 100 pF	CRL	DD-101
J9	Coupling Snap	Phelps-Dodge	700209
P9	Coupling Snap	Phelps-Dodge	700156
	Heat Sink	Wakefield	213CB
P2	Housing (4 Pin)	Amp	87133-4
P3	Housing (10 Pin)	Amp	87133-5
Z201	Integrated Circuit	Motorola	MC1469R
Z202	Integrated Circuit	Motorola	MC1463R
Z203	Integrated Circuit	Signetics	UA723CA
R201	Resistor, 2Ω 1/2W		RC20GF2R0
R202	Resistor, 1K 1/4W		RC07GF102J
R203	Resistor, 10K 1/4W		RC07GF103J
R204	Resistor, 14K, 1% 1/8W		RN60C1402F
R206, R207 R214	Resistor, 6.81K, 1%, 1/8W		RN60C6811F
R208	Resistor, 16.9K, 1% 1/8W		RN60C1692F

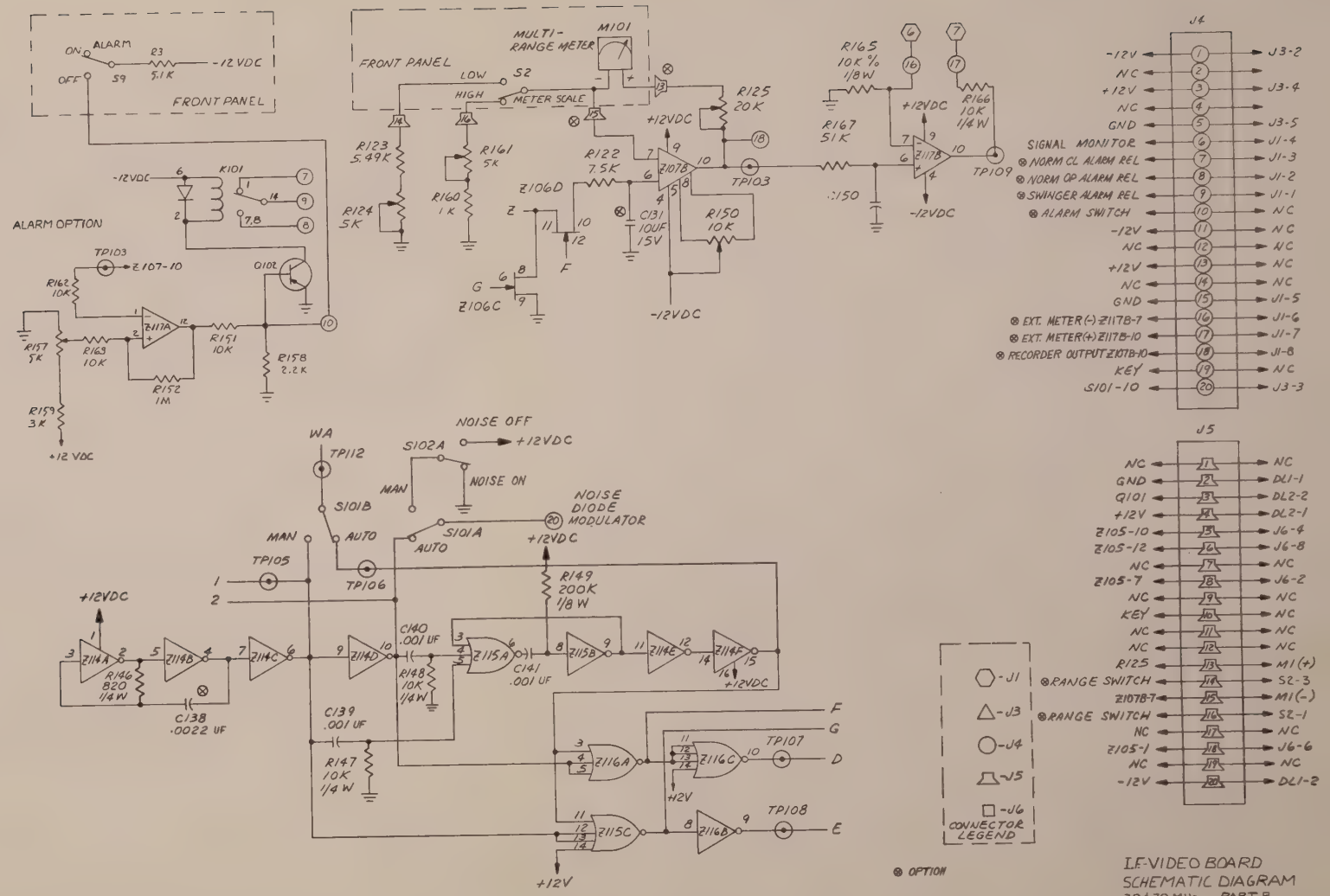

R201 2Ω 1/2 W
R202 1K
R203 10K
Z201
R204 14K 1%
R205 5.0K
R206 6.8K 1%
C204 0.1 UF
TP201
C202 1000UF 25V
Q201
C203 0.001 UF
J3
J4-5
TP202
+12VDC
J4-3
C201 10UF 25V.
J4-20
KEY
R207 6.8K 1%
R208 17K 1%
Z202
TP204
-12VDC
J4-1
C205 10UF 25V
+5VDC△
230 VAC
230VAC CONNECTION
C207 0.1 UF
TP203
R209 5Ω
C208 0.001 UF
J2
T201
KEY
S1
CR201
C206 500UF 25V
R212 10Ω
TP206
J9
TO J7 (REAR PANEL)
R211 2K
Q202
R210 15K
C210 100PF
Z203
R214 6.8K 1%
R215 500Ω
R213 5.1K
R216 2.0K 1%
TP205
C209 200UF 50V.
115 VAC
F1
AC GRD.
CR202
* BUSS WIRE JUMPER CONNECTIONS
TP208
Z204
TP207
+5VDC△
C211 2000UF 50V.
C212 10UF 16V.
CR203
POWER SUPPLY BOARD 298021-
△ THE +5VDC SUPPLY IS USED IN SOME MODELS

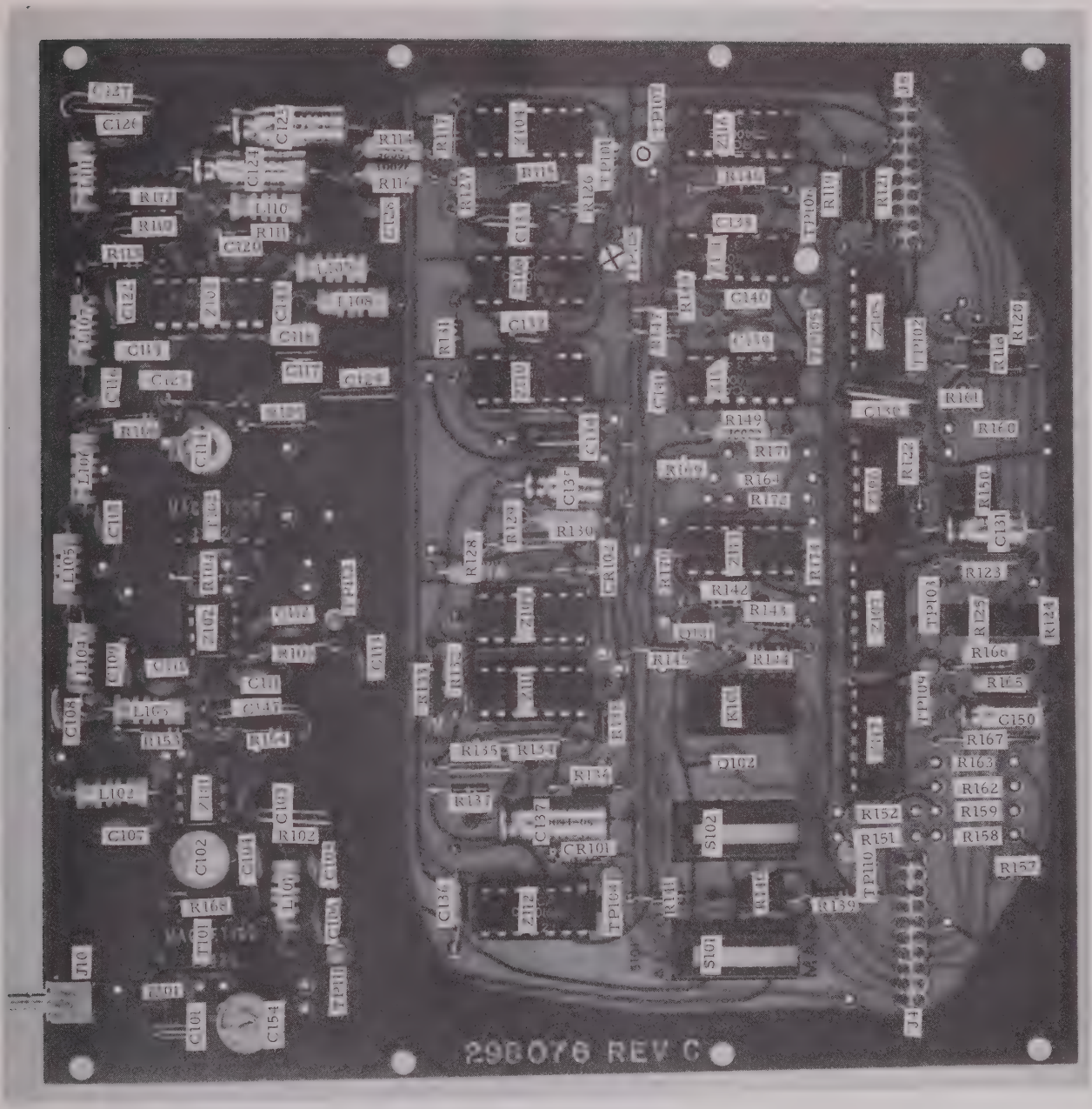


POWER SUPPLY BOARD ASSEMBLY 298021



I.F.-VIDEO BOARD
SCHEMATIC DIAGRAM
30-70 MHz PART A

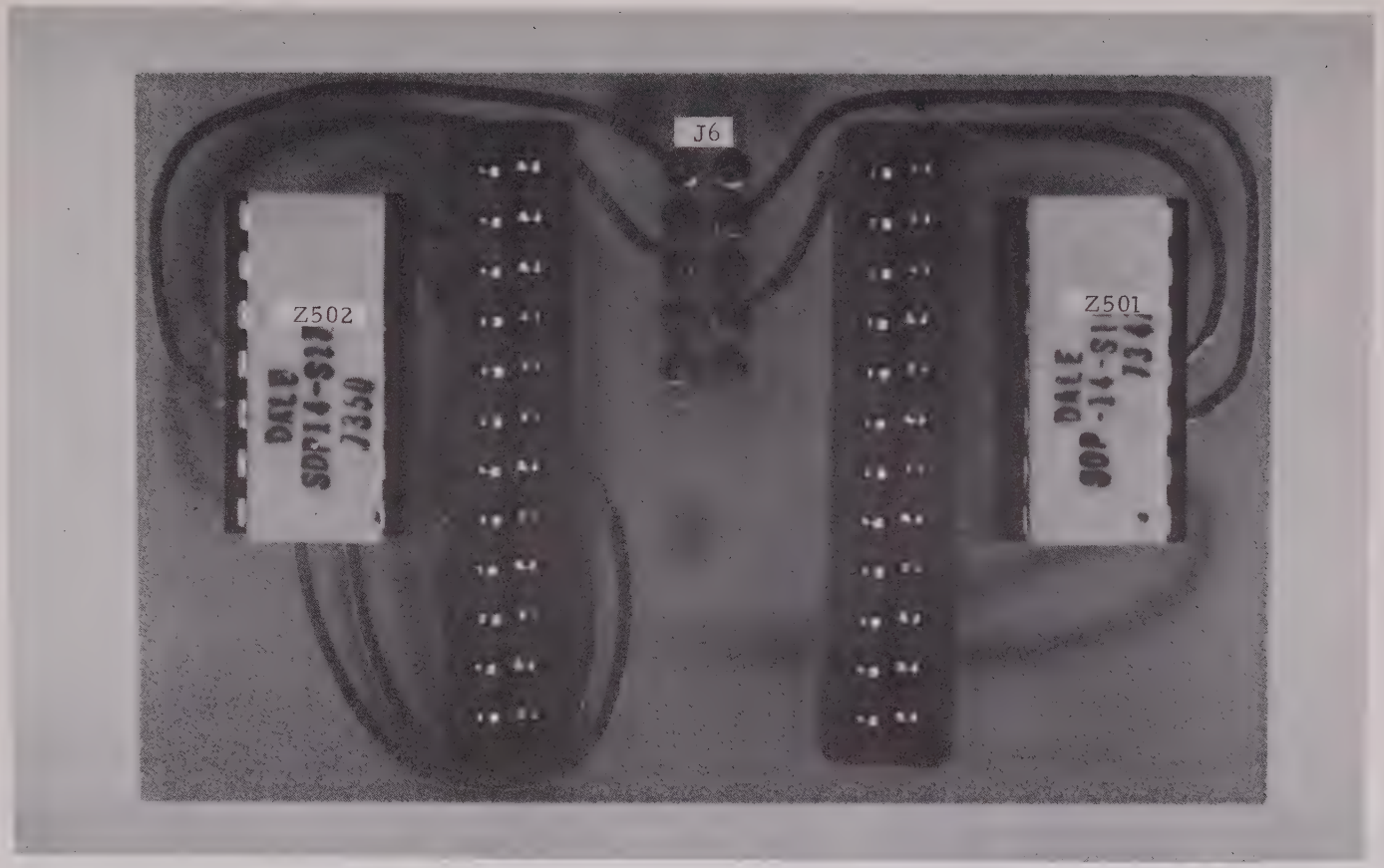

ALARM
ON
OFF
S9
R3
5.1K
-12VDC
FRONT PANEL
ALARM OPTION
K101
-12VDC
TP103
Z107-10
Q102
R162
10K
R157
5K
R163
10K
Z117A
R151
10K
R158
2.2K
R152
1M
R159
3K
+12 VDC
MULTI-
RANGE METER
M101
FRONT PANEL
LOW
S2
HIGH
METER SCALE
R123
5.49K
R124
5K
R161
5K
R160
1K
Z106D
Z106C
R122
7.5K
Z107B
C131
10UF
15V
R150
10K
TP103
+12VDC
-12VDC
R125
20K
R165
10K %
1/8W
R167
51K
R166
10K
1/4W
Z117B
TP109
-12VDC
J4
-12V
NC
+12V
NC
GND
SIGNAL MONITOR
NORM CL ALARM REL
NORM OP ALARM REL
SWINGER ALARM REL
ALARM SWITCH
-12V
NC
+12V
NC
GND
EXT. METER(-) Z117B-7
EXT. METER(+) Z117B-10
RECORDER OUTPUT Z107B-10
KEY
S101-10
J3-2
J3-4
J3-5
J1-4
J1-3
J1-2
J1-1
NC
NC
NC
NC
J1-5
J1-6
J1-7
J1-8
NC
J3-3
WA
TP112
S102A
NOISE OFF
+12VDC
MAN
NOISE ON
S101B
AUTO
S101A
AUTO
NOISE
DIODE
MODULATOR
+12VDC
MAN
TP105
TP106
1
2
R149
200K
1/8 W
+12VDC
Z114A
Z114B
Z114C
Z114D
C140
.001 UF
Z115A
C141
.001 UF
Z115B
Z114E
Z114F
+12VDC
R146
820
1/4 W
C138
.0022 UF
C139
.001 UF
R148
10K
1/4W
R147
10K
1/4 W
Z116A
Z116C
TP107
+12V
Z115C
Z116B
TP108
+12V
F
G
D
E
J5
NC
GND
Q101
+12V
Z105-10
Z105-12
NC
Z105-7
NC
KEY
NC
NC
NC
R125
RANGE SWITCH
Z107B-7
RANGE SWITCH
NC
Z105-1
NC
-12V
NC
GND
J1
J3
J4
J5
J6
CONNECTOR
LEGEND
OPTION
I.F. VIDEO BOARD
SCHEMATIC DIAGRAM
30¢ 70 MHz PART B



I. F. VIDEO BOARD 298020

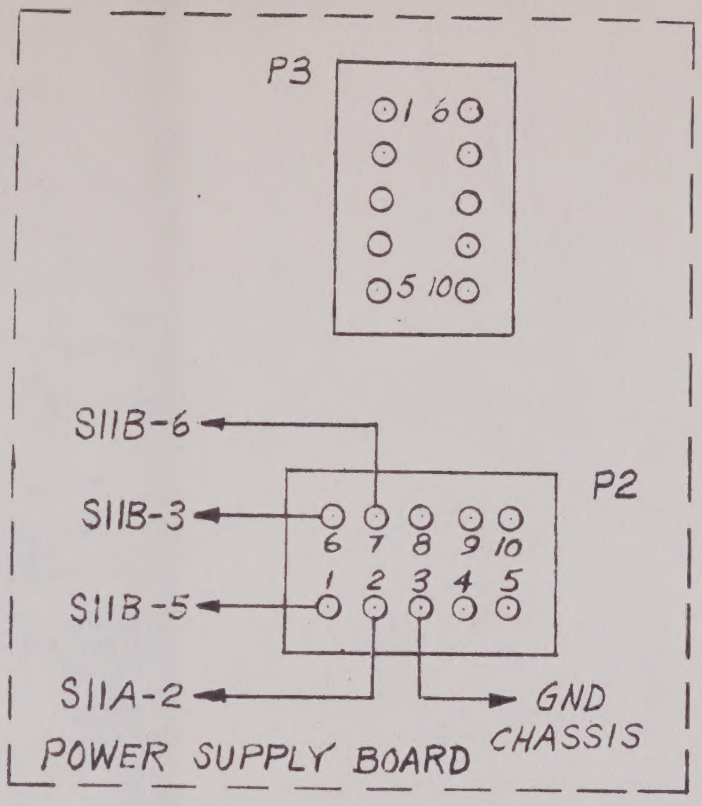
ASSEMBLY

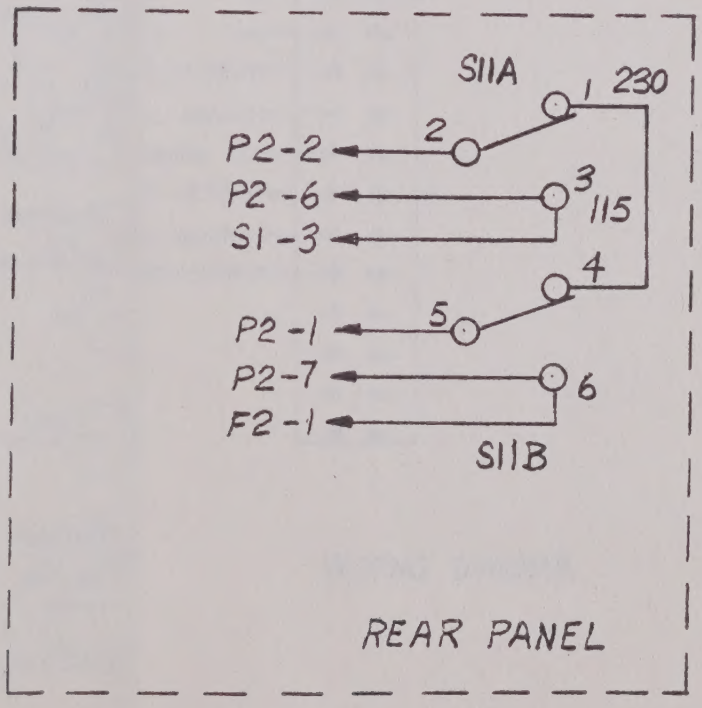
(30 MHz & 70 MHz)



SYSTEM ENR BOARD 298172

ASSEMBLY



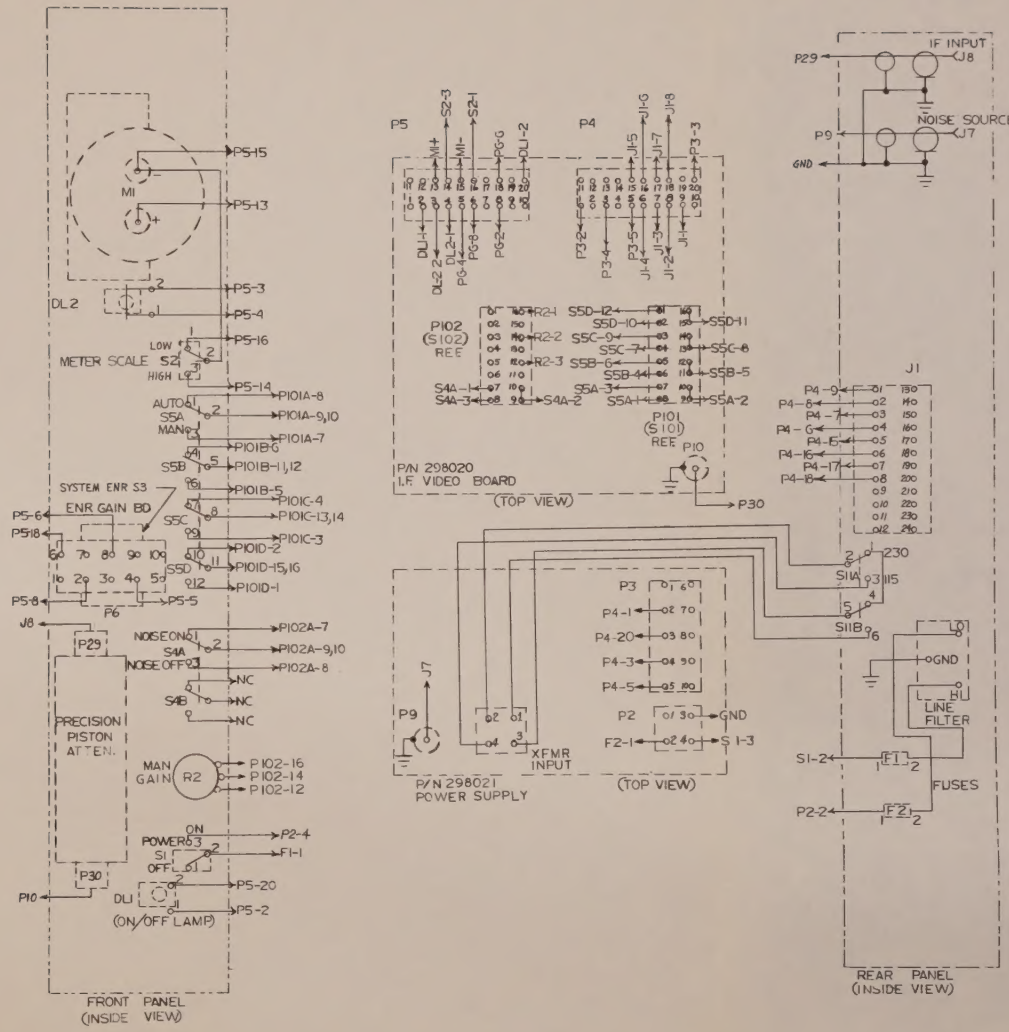


REVISION

WIRING DIAGRAM

D299149 REV A

7310, 7320, 7330



WIRING DIAGRAM